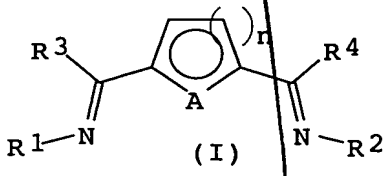
We claim:

1. A compound of the formula (I)



(I)

where the symbols have the following meanings:

A is a nonmetal selected from among N, S, O and P,

R^1 is a radical of the formula NR^5R^6,

R^2 is a radical of the formula NR^5R^6 or NR^7R^8, alkyl, aryl or cycloalkyl,

R^5 and R^6 together with the N atom form a 5-, 6- or 7-membered ring in which one or more of the -CH- or $-CH_2-$ groups may be replaced by suitable heteroatom groups and which may be saturated or unsaturated and unsubstituted or substituted or be fused with further carbacyclic or heterocarbacyclic 5- or 6-membered rings which may in turn be saturated or unsaturated and substituted or unsubstituted, and

R^7 and R^8 are, independently of one another, alkyl, aryl or cycloalkyl radicals,

and

R^3, R^4 are, independently of one another, H or alkyl, aryl or cycloalkyl radicals,

and

n is 1 or 2.

2. A compound as claimed in claim 1, wherein the radicals of the formula NR^5R^6 are pyrrole radicals or radicals derived from pyrrole in which one or more -CH- groups in the pyrrole ring may be replaced by nitrogen and which may be unsubstituted or substituted or fused with further carbacyclic or

heterocarbacyclic 5- or 6-membered rings which may in turn be saturated or unsaturated and substituted or unsubstituted.

3. A compound as claimed in claim 2, wherein the pyrrole radicals or radicals derived from pyrrole are substituted in the 2 and 5 positions by C_1-C_6-alkyl groups which may be linear, branched or substituted by heteroatoms, and/or by aryl groups which may be unsubstituted or in turn substituted by heteroatoms or C_1-C_6-alkyl groups which may be heteroatom-substituted.

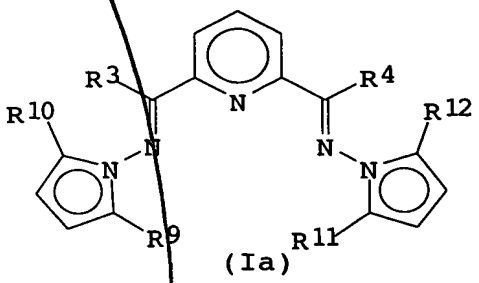
4. A compound as claimed in claim 1 or 2, wherein the pyrrole radicals or radicals derived from pyrrole are substituted in the 2 or 5 position by electron-withdrawing radicals selected from among

- halogen,
- NO_2,
- sulfonates selected from among
  - SO_3R^*,
  - $SO_3SiR^*_3$ and
  - SO_3^- $(H{-}NR^*_3)^+$,
  - -trihalomethyl,

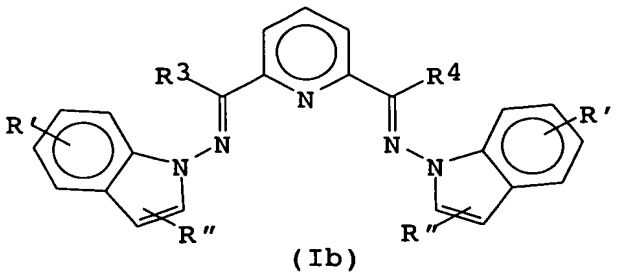
where R^* may be identical or different and are selected from among H, C_1–C_{10}–alkyl, C_6–C_{20}–aryl and C_5-C_8-cycloalkyl.

5. A compound as claimed in any of claims 1 to 4, wherein, in the formula (I) of claim 1, A = N and n = 2.

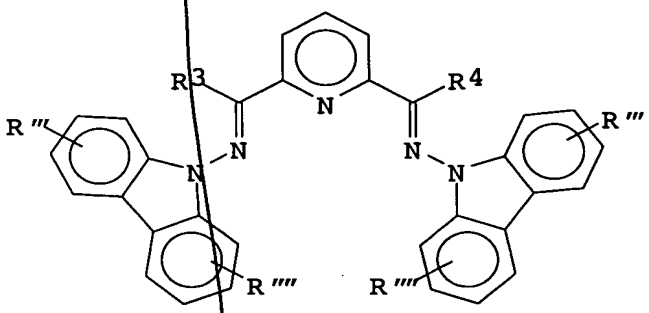
6. A compound as claimed in claim 5 which corresponds to one of the formulae (Ia), (Ib), (Ic) and (Id):



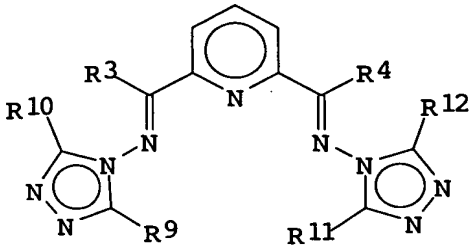
(Ia)



(Ib)



(Ic)



(Id)

where

R^3, R^4 are, independently of one another, H or alkyl or aryl radicals,

and

R^9, R^{10}, R^{11} and R^{12} are, independently of one another, C_1-C_6-alkyl radicals, and

R', R'', R''', R'''' are H or alkyl, aryl or cycloalkyl radicals.

7. A process for preparing symmetrical compounds of the formula (I) of claim 1 in which $R^1 = R^2$ by reacting compounds of the formula (II)

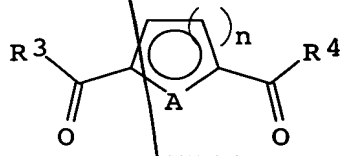
$$H_2N-NR^5R^6 \quad (II)$$

where

R^5 and R^6 together with the N atom form a 5-, 6- or 7-membered ring in which one or more of the -CH- or -CH_2- groups may be replaced by suitable heteroatom groups and which may be saturated or unsaturated and unsubstituted or substituted or fused with further carbacyclic or

heterocarbacyclic 5- or 6-membered rings which may in turn be saturated or unsaturated and substituted or unsubstituted,

with compounds of the formula (III)



(III)

where

R^3, R^4 are, independently of one another, H or alkyl, aryl or cycloaklyl radicals, and

A is S, N, O or P, and,

n is 1 or 2, and

in a single-stage process under acidic reaction conditions in alcoholic solution or in the presence of a trialkylaluminum catalyst in an aprotic solvent in a ratio of the compound of the formula (II) to the compound of the formula (III) of 2:0.7-1.3.

8. A process for preparing unsymmetrical compounds of the formula (I) of claim 1 in which $R^1 \neq R^2$ in a two-stage process in which

a) in a first step, compounds of the formula (II)

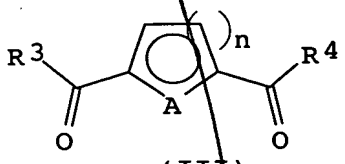
$H_2N-NR^5R^6$ (II)

where

R^5 and R^6 together with the N atom form a 5-, 6- or 7-membered ring in which one or more of the -CH- or $-CH_2-$ groups may be replaced by suitable heteroatom groups and which may be saturated or unsaturated and substituted or unsubstituted or fused with further carbacyclic or heterocarbacyclic 5- or 6-membered rings which may in

turn be saturated or unsaturated and substituted or unsubstituted,

are reacted with compounds of the formula (III)



(III)

where

R^3, R^4 are, independently of one another, H or alkyl, aryl or cycloalkyl radicals, and

A is S, N, O or P, and

n is 1 or 2,

in a ratio of the compounds of the formula (II) to the compounds of the formula (III) of 1:0.8-1.2 under acidic conditions in alcoholic solution to form the corresponding monoimine and the solvent is subsequently removed under reduced pressure,

and

b) the monoimine is, in a second step, reacted with compounds of the formula (II) which differ from the compounds of the formula (II) used in step a) or with compounds of the formula (IV)

$$H_2N-NR^7R^8 \quad (IV)$$

where

R^7 and R^8 are, independently of one another, alkyl, aryl or cycloalkyl radicals,

or with amines of the formula (V)

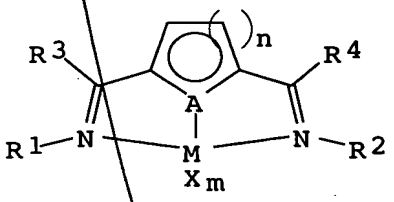
$$R^{13}-NH_2 \quad (V)$$

where

R^{13} is an alkyl, aryl or cycloalkyl radical,

in aprotic solution in the presence of a trialkylaluminum catalyst in a ratio of the monoimine to the compound of the formula (II), (IV) or (V) of 1:0.8-1.2.

9. A compound of the formula (VI),



(VI)

where the symbols have the following meanings:

A is a nonmetal selected from among N, S, O and P,

R^1 is a radical of the formula NR^5R^6,

R^2 is a radical of the formula NR^5R^6 or NR^7R^8, alkyl, aryl or cycloalkyl,

R^5 and R^6 together with the N atom form a 5-, 6- or 7-membered ring in which one or more of the -CH- or $-CH_2-$ groups may be replaced by suitable heteroatom groups and which may be saturated or unsaturated and unsubstituted or substituted or be fused with further carbacyclic or heterocarbacyclic 5- or 6-membered rings which may in turn be saturated or unsaturated and substituted or unsubstituted, and

R^7 and R^8 are, independently of one another, alkyl, aryl or cycloalkyl radicals,

and

R^3, R^4 are, independently of one another, H or alkyl, aryl or cycloalkyl radicals,

n is 1 or 2,

M is a transition metal of groups 7, 8, 9 or 10 of the Periodic Table of the Elements,

and

X is a halide or a C_1-C_6-alkyl radical and

m is the valence of the metal.

10. A compound as claimed in claim 9, wherein M = Fe or Co and m = 2.

11. A process for preparing compounds of the formula (VI) of claim 9 by reacting corresponding compounds of the formula (I) as claimed in any of claims 1 to 5 with salts of transition metals of groups 7, 8, 9 or 10 of the Periodic Table of the Elements.

12. The use of compounds of the formula (VI) as claimed in claim 9 or 10 as catalysts in a process for the polymerization of unsaturated compounds.

13. A process for preparing polyolefins by polymerization of unsaturated compounds in the presence of an activator and a compound of the formula (VI) as claimed in claim 9 or 10 as catalyst.

14. A process as claimed in claim 13, wherein the catalyst is present in the polymerization either as a homogeneous solution or in heterogeneous form immobilized on a support.

15. A process as claimed in claim 13 or 14, wherein methylaluminoxane or N,N-dimethylanilinium tetrakis(pentafluorophenyl)borate is used as activator.

16. A process as claimed in any of claims 13 to 15, wherein an unsaturated compound or a combination of unsaturated compounds selected from among ethylene, C_3-C_{20}-monoolefins and cycloolefins is used.

17. A process as claimed in any of claims 13 to 15, wherein acrylonitrile and styrene are used as comonomers or the following combinations of unsaturated compounds are employed: ethylene and an alkyl acrylate, in particular methyl acrylate, ethylene and an acrylic acid, ethylene and carbon monoxide, ethylene, carbon monoxide and an acrylate ester or

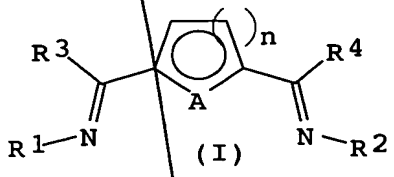
an acrylic acid, in particular methyl acrylate, and also propylene and alkyl acrylate, in particular methyl acrylate.

18. A polyolefin which can be prepared in a process as claimed in any of claims 1 to 17.

Catalysts for the polymerization of unsaturated compounds

Abstract

Bisimine compounds of the formula (I)



(I)

where the symbols have the following meanings:

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R^1 is a radical of the formula NR^5R^6,

R^2 is a radical of the formula NR^5R^6 or NR^7R^8, alkyl, aryl or cycloalkyl,

R^5 and R^6 together with the N atom form a 5-, 6- or 7-membered ring in which one or more of the -CH- or $-CH_2-$ groups may be replaced by suitable heteroatom groups and which may be saturated or unsaturated and unsubstituted or substituted or be fused with further carbacyclic or heterocarbacyclic 5- or 6-membered rings which may in turn be saturated or unsaturated and substituted or unsubstituted, and

R^7 and R^8 are, independently of one another, alkyl, aryl or cycloalkyl radicals,

and

R^3, R^4 are, independently of one another, H or alkyl, aryl or cycloalkyl radicals,

and

n is 1 or 2,

are used to prepare bisimidinato complexes which can be used in the polymerization of unsaturated compounds.